06EC756- IMAGE PROCESSING

Dept of TCE

Siddiq Iqbal

06EC756- IMAGE PROCESSING
SYLLABUS

Subject Code : **06EC756** IA Marks : 25
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03
Total no. of Lecture Hrs. : 52 Exam Marks : 100

PART - A

UNIT – 1 **6 Hours**

DIGITAL IMAGE FUNDAMENTALS: What is Digital Image Processing. Fundamental Steps in Digital Image Processing, Components of an Image processing system, elements of Visual Perception.

UNIT – 2 **6 Hours**

IMAGE SENSING AND ACQUISITION: Image Sampling and Quantization, Some Basic Relationships between Pixels, Linear and Nonlinear Operations.

UNIT – 3 **6 Hours**

IMAGE TRANSFORMS: Two-dimensional orthogonal & unitary transforms, properties of unitary transform, two dimensional discrete Fourier transform.

UNIT – 4 **6 Hours**

Discrete cosine transform, sine transform, Hadamard transform, Haar transform, Slant transform, KL transform.

PART - B

UNIT – 5 **6 Hours**

IMAGE ENHANCEMENT: Image Enhancement in Spatial domain, Some Basic Gray Level Trans - formations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations.

UNIT – 6 **6 Hours**

Basics of Spatial Filtering Image enhancement in the Frequency Domain filters, Smoothing Frequency Domain filters, Sharpening Frequency Domain filters, homomorphic filtering.

UNIT – 7 **10 Hours**

Model of image degradation/restoration process, noise models, Restoration in the Presence of Noise, Only-Spatial Filtering Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, inverse filtering, minimum mean square error (Weiner) Filtering.

UNIT – 8 **6 Hours**

COLOR FUNDAMENTALS: Color Models, Pseudo color Image Processing., processing basics of full color image processing.

TEXT BOOK:

1. **Digital Image processing**– Rafael C.Gonzalez and Richard E.Woods, Pearson Education, 2001, 2nd edition.

REFERENCE BOOKS:

1. **Fundamentals of Digital Image Processing**– Anil K. Jain,Pearson Edun, 2001.
2. **Digital Image Processing and Analysis** – B. Chanda and D. Dutta Majumdar, PHI, 2003.

LESSON PLAN

UNIT	DATE	TOPIC	NO. OF HRS	% OF COVERAGE CUMULATIVE	REMARKS
1	01/08	**DIGITAL IMAGE FUNDAMENTALS:** What is Digital Image Processing?	1	11.5%	VTU – 6 Hrs Planned – 6 Hrs
	02/08	Fundamental Steps in Digital Image Processing,	1		
	04/08	Components of an Image processing system	1		
	06/08	elements of Visual Perception- Structure of Human eye	1		
	08/08	Image formation, brightness adaptation & discrimination, Weber ratio	1		
	09/08	Brightness Vs function of intensity, simultaneous contrast, Human perception phenomena	1		
2	11/08	**IMAGE SENSING AND ACQUISITION:** 3 principal sensor arrangements, 2-D image using a single sensor, Image Acquisition Using Sensor Strips	1	23%	VTU – 6 Hrs Planned – 6 Hrs
	13/08	Image Acquisition Using Sensor Arrays, A Simple Image Formation Model	1		
	16/08	Image Sampling and Quantization	1		
	18/08	Resolution, non-uniform sampling, Representative isopreference curves, Aliasing and Moiré Patterns	1		
	20/08	Zooming and Shrinking Digital Images	1		
	22/08	Some Basic Relationships between Pixels, Linear and Nonlinear Operations.	1		
3	23/08	**IMAGE TRANSFORMS:** Two-dimensional orthogonal & unitary transforms	1	34.6%	VTU – 6 Hrs Planned – 6 Hrs
	25/08	Properties of unitary transform	1		
	27/08	Properties(Contd...)	1		
	29/08	One-Dimensional discrete Fourier transform, properties	1		
	30/08	Properties of 1-D DFT(Contd...)	1		
	03/09	two dimensional discrete Fourier transform	1		
4	08/09	Discrete cosine transform & its properties	1	46.1%	VTU – 6 Hrs Planned – 6 Hrs
	10/09	Sine transform & its properties	1		
	12/09	Hadamard transform & its properties	1		
	13/09	Haar transform & its properties	1		
	15/09	Slant transform & its properties	1		
	17/09	KL transform & its properties	1		

UNIT	DATE	TOPIC	NO. OF HRS	% OF COVERAGE CUMULATIVE	REMARKS
5	19/09	**IMAGE ENHANCEMENT:** Image Enhancement in Spatial domain	1	57.7%	VTU – 6 Hrs Planned – 6 Hrs
	20/09	Some Basic Gray Level Trans -formations	1		
	22/09	Gray Level Trans –formations (Contd...)	1		
	24/09	Histogram Processing	1		
	26/09	Histogram Processing (Contd...)	1		
	29/09	Enhancement Using Arithmetic/Logic Operations	1		
6	01/10	Basics of Spatial Filtering	1	69.23%	VTU – 6 Hrs Planned – 6 Hrs
	03/10	Image enhancement in the Frequency Domain filters	1		
	04/10	Frequency Domain filters (Contd...)	1		
	08/10	Smoothing Frequency Domain filters	1		
	10/10	Sharpening Frequency Domain filters	1		
	17/10	Homomorphic filtering	1		
7	18/10	Model of image degradation/restoration process, noise models	1	88.4%	VTU – 10 Hrs Planned – 08 Hrs
	20/10	Noise models	1		
	22/10	Restoration in the Presence of Noise	1		
	24/10	Restoration in the Presence of Noise (Contd...)	1		
	29/10	Only-Spatial Filtering Periodic Noise Reduction by Frequency Domain Filtering	1		
	31/10	Only-Spatial Filtering Periodic Noise Reduction by Frequency Domain Filtering (Contd...)	1		
	03/11	Linear Position-Invariant Degradations	1		
		Linear Position-Invariant Degradations (Contd...)			
	05/11	Inverse filtering	1		
		Minimum mean square error (Weiner) Filtering			
8	08/11	**COLOR FUNDAMENTALS:** Color Models	1	100%	VTU – 6 Hrs Planned – 4 Hrs
	15/11	Color Models (Contd...)	1		
	17/11	Pseudo color Image Processing	1		
		Pseudo color Image Processing (Contd...)			
	19/11	Processing basics of full color image processing	1		
		Processing basics of full color image processing (Contd...)			

QUESTION BANK

PART – A

UNIT 1: Digital Image Fundamentals

1. What is Digital Image processing? State & explain the computerized processes used in DIP.
2. With a neat block diagram, explain the fundamental steps in digital image processing.
3. With the help of a neat block diagram, explain the components of a general purpose image processing system. Give an example for each of the component and explain how this system is different from other systems.
4. Draw & explain the structure of Human eye.
5. In connection with image processing system state:
   i) Important application areas where image processing is essential.
   ii) Components of an image processing system.
6. Explain the following term as applicable to image processing with necessary graphs.
   i) Cones and Rods ii) Brightness adaptation iii) Isopreference
7. Discuss the different classes of receptors.
8. With the help of a diagram explain the distribution of rods & cones in the retina
9. Describe the principle of image formation in Human eye
10. Explain brightness adaptation & discrimination
11. Define Weber ratio
12. Explain in detail Mach bands & perceived brightness with diagrams.
13. Discuss optical illusions with examples

UNIT 2: Image Sensing and Acquisition

1. Discuss Image Sensing & Acquisition
2. Explain how image acquisition is done using single sensor?
3. Explain Microdensitometer type of image acquisition system
4. Explain how image acquisition is done using sensor strips?
5. With An example explain digital image acquisition process
6. Explain the Illumination & reflectance model of the image
7. Discuss the role of sampling & quantization processes with an example
8. Discuss the role of sampling & quantization processes with an example
9. Define spatial resolution & gray level resolution
10. Explain the following
    a. False contouring
    b. Aliasing & Moiré patterns
11. Explain any two methods used for digital image zooming & shrinking.
12. What are the basic relationships between pixels? With neat diagrams and appropriate mathematical expressions explain: i) Neighbors ii) Adjacency iii) Connectivity
13. Define different types of adjacency & explain how m - adjacency is different from 8 - adjacency with an example. Calculate the number of bits required to store a digital image of size 1024x 1024 pixels, given 128 number of gray levels
14. Write a note on different distance measures
15. Let p & q be the pixels at coordinates (10, 12) & (15, 20) respectively. Find out which distance measure gives the minimum distance between them
16. For pixels p, q with co-ordinates (x, y) and (s, t) respectively find the distance metric D for the following cases:
    a. Euclidean distance De (p, q)
    b. City block distance D_4 (p, q)
    c. Chessboard distance Dg (p, q)

17. Write a note on Image Operations on a Pixel Basis
18. Explain linear & non linear operations

UNIT 3: IMAGE TRANSFORMS

1. Define Image transforms & Basis images
2. State the properties of 1D DFT/Unitary DFT.
3. Discuss two dimensional orthogonal & unitary transforms & their properties.
4. Prove the following properties of orthogonal unitary transforms:
   a. Energy conservation & rotation
   b. Energy compaction & variances
   c. Decorrelation
5. For the 2 x 2 transform A & the image U, calculate the transformed image V and the basis images $A = \frac{1}{2}\begin{bmatrix} \sqrt{3} & 1 \\ -1 & \sqrt{3} \end{bmatrix}$ & $U = \begin{bmatrix} 2 & 3 \\ 1 & 2 \end{bmatrix}$ & verify the same by finding the inverse of V.
6. Discuss the properties of 2D discrete Fourier Transform & prove circular convolution theorem.
7. Explain in brief the following as applied to the Discrete Fourier Transform.
   i) Convolution theorem iii) Conjugate symmetry ii) Periodicity iv) Separability

UNIT 4: IMAGE TRANSFORMS (Contd…)

1. Give an expression for Discrete Cosine Transform & its inverse for a sequence u (n). Explain its properties.
2. Give an expression for Discrete Sine Transform & its inverse for a sequence f(x). Explain its properties.
3. Construct the Hadamard transform matrix of N = 4 & discuss Hadamard order. Explain its properties.
4. Construct the Haar transform matrix of N = 8. Explain its properties.
5. Construct the Slant transform matrix for n = 3. Explain its properties.
6. Discuss sequency with respect to slant transform
7. Give an expression for KL transform. Explain its properties.

PART – B

UNIT 5: IMAGE ENHANCEMENT

1. What are principle objectives of image enhancement?
2. State the different types of processing used for image enhancement.
3. Explain the Basic Gray Level Transformations used in image enhancement.
4. Discuss in detail Piecewise-Linear Transformation Functions.
5. Explain: i) Contrast stretching ii) Gray level slicing iii) Bit plane slicing.
6. What is a histogram? Briefly explain the histogram equalization technique for image enhancement.
7. For the image in fig.Q3, calculate the resultant image after histogram equalization.

2	3	3	2
4	2	4	3
3	2	3	5
2	4	2	4

Fig.Q3

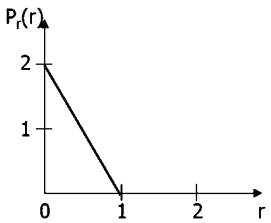

Fig.Q4(a)

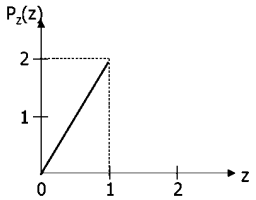

Fig.Q4(b)

8. An image has the gray level PDF $P_r(r)$ shown in fig.Q4(a). It is desired to transform the gray levels of this image so that they will have the specified $P_Z(z)$ shown in fig.Q4 (b). Find the transformation in terms of r & z that will accomplish this.
9. Explain image enhancement using Arithmetic & Logic operations.

UNIT 6: IMAGE ENHANCEMENT (Contd…)

1. What are the basic steps for image filtering in frequency domain? Explain with a block diagram.
2. Explain in detail Smoothing Frequency-domain filters (Low pass) related to images.
3. Explain in detail Sharpening Frequency-domain filters (High pass) related to images.
4. Draw the Spatial representation of Ideal, Butterworth and Gaussian high pass filters
5. With an example Laplacian in the Frequency domain
6. Explain Unsharp Masking, High-Boost Filtering, & High frequency Emphasis Filtering
7. With the help of a neat block diagram, explain the Homomorphic filtering.

UNIT 7: IMAGE RESTORATION

1. What is Image Restoration? How is it different from Image Enhancement?
2. Explain the Model of image degradation/restoration process.
3. With the help of PDFs explain the noise models.
4. With relevant probability density function, explain
   a) Rayleigh noise b) Erlang noise c) Impulse (salt & pepper) noise
5. How the estimation of noise parameters are done.
6. What are adaptive filters? What are the advantages of these filters? Explain local noise reduction adaptive mean filters.
7. Explain Adaptive median filter stating its advantages.
8. With necessary expressions, explain the periodic noise reduction by frequency domain filtering with respect to notch filter.
9. Discuss the minimum mean square error (Wiener) filtering.

UNIT 8: COLOR FUNDAMENTALS

1. Explain the various color models in color image processing stating advantages & applications of each model.
2. Explain with necessary expressions, the procedure for converting colors RGB to HSI and vice versa.
3. With the help of block diagram explain Pseudo color Image Processing